BOTANY.[1]

The Flora of Chicago.[2]—In this clearly printed catalogue the authors have made a valuable addition to the list of local floras of this country. Very properly the catalogue is prefaced by a brief sketch of Prof. H. H. Babcock, who did so much to make known to the world the peculiarities of the vegetation of Chicago and its vicinity. Then follows an interesting chapter on the geology of the region covered by the catalogue. At the close of the chapter the matter is summed up as follows: "Though Cook county, Illinois, and Lake county, Indiana, have neither mountains nor valleys, no frowning cliffs nor rocky glens, they have an interesting geological history, the outcome of which is a very unique botanical area. The rolling prairies, the river bottoms, the sandy ridges, the lake shore, the drift clay and its ravines, the sloughs among the ridges at the south end of the lake, the peat logs which are found in many places, the shallow ponds and sluggish streams, give a great variety of soil for native plants."

In this area there are catalogued 1,140 species and varieties of native plants, 182 of which have been introduced. The largest order is the Compositæ, with 170 species and 19 varieties. The next in order are: Cyperaceæ, 97 species and 19 varieties; Gramineæ, 85 species and 5 varieties. The largest genus is Carex, with 55 species and 15 varieties. The Pteridophytes have 31 representatives. No attempt is made to enumerate the mosses, liverworts, fungi, etc.

The conformation of the nomenclature to modern ideas, and the uniform "decapitalization" of specific names, will commend this catalogue to the majority of the botanists of the country.—CHARLES E. BESSEY.

The Action of Bacteria on the Rapid Souring of Milk During Thunder Storms.—That milk will sour with unusual rapidity during thunder storms is a theory very commonly held among dairymen, and probably is to a certain extent true. It has been stated by various writers that this is due to an oxidation of the milk by the ozone generated in the air at such times, the oxygen of the air being converted into ozone by the electrical discharges.

[1] Edited by Dr. Charles E. Bessey, University of Nebraska, Lincoln.

[2] The Flora of Cook County, Illinois, and a Part of Lake County, Indiana. By William K. Higley and Charles S. Raddin. In the Bulletin of the Chicago Academy of Sciences, Vol. II., No. 1, Chicago, 1891.

This is the conclusion to which two investigators have recently arrived as a result of their experiments.[3] These two, though differing somewhat in methods, arrived at practically the same conclusions,—viz., 1. Ozone will attack milk, and produce lactic acid by a process of direct oxidation; 2. During a thunder storm sufficient ozone is generated by the electrical discharges to exert this oxidizing action on milk.

The method of both these experimenters, in brief, was to expose milk to the action of ozone generated by a spark of electricity passing through oxygen. This was done in a closed vessel, partly filled with milk, and the air above the milk displaced by oxygen; ozone could then be generated by passing a spark across through the oxygen. According to both observers, a spark passed in this way from fifteen to twenty minutes would generate enough ozone to coagulate the milk in less than an hour. According to Prof. Tolomei, this action is even more rapid if, instead of a spark, a "silent discharge" of electricity from the two poles of the battery be employed. This is due simply to the fact that a larger amount of ozone can be generated from a given quantity of oxygen by the "silent discharge" than by a spark.

These results differ considerably from some obtained in this laboratory some time ago. Since the publication of Tolomei's work ours has been repeated, and gives exactly the same results as were obtained before.

Our methods were similar to those described above. A Wolff bottle was taken and filled with milk and oxygen. Wires connected with a Holtz induction machine were then passed in at the opposite necks of the bottle, and ozone generated by passing electricity, either as a spark or in the form of a silent discharge, across through the oxygen. A second bottle was partly filled with milk and kept as a control.

Although repeated over and over, under various conditions of temperature, and with milk of various degrees of sweetness, from that just from the cow to that a day or more old, in no case were we able to produce any such rapid souring as was described by Iles and Tolomei. We did, however, get a slight hastening of the time of souring. If the control coagulated in thirty-six hours, that experimented on would coagulate only an hour or two earlier. Moreover, we found that free oxygen alone was sufficient to produce this slight hastening.

[3] D. W. Iles, *Chemical News*, Vol. 36, p. 237, 1877. Prof. Tolomei, *Biedermann's Centralblatt für Agriculturchemie*, 1890, p. 538.

A further experiment showed that if the milk used be *sterilized* before it is treated with oxygen and ozone, and is then protected from contact with unfiltered air, no coagulation occurs, no matter how much oxygen is introduced. We have subjected sterilized milk to the action of the electric spark for over an hour, and then kept this milk in our laboratory two months, without the appearance of the least sign of coagulation.

From the fact that only a slight hastening of the time of souring resulted in the case of ordinary milk, and that no coagulation at all was produced if the milk were sterilized, we conclude that the process cannot be one of oxidation, but is due rather to the rapid growth of the bacteria of the milk under the influence of the free oxygen, and, possibly, to a certain extent, of the ozone also.

It is possible that during a thunder storm a sufficient amount of ozone may be generated to stimulate the bacteria and bring on a rapid souring. It seems very improbable, however, that the small amount of ozone usually produced at such a time could have any such effect.

The true cause, it seems to us, is to be found in the warm, sultry atmosphere which usually precedes and accompanies these storms. These atmospheric conditions, as is well known, are especially favorable to the growth of bacteria, and this rapid growth brings on a correspondingly rapid souring of the milk.

These are, in brief, the conclusions at which we have arrived from the results of our experiments. They are, to a certain extent, borne out by the experience of the proprietor of a neighboring creamery. He finds that if milk be kept at a uniformly low temperature, no trouble results from souring during the thunder-storm season.

It will be seen from the above that ozone, at least in the small amount (about five per cent.) which can be generated from a given amount of oxygen by the electric spark, is not destructive to the bacteria which causes the souring of milk. This fact is of interest, in view of the common use of ozone as a disinfectant.—AARON L. TREADWELL, *Biological Laboratory, Wesleyan University.*

The Parry Herbarium.—This important collection of plants has been carefully arranged and catalogued, and is now offered for sale by Mrs. E. R. Parry, the widow of Dr. Parry. It is particularly rich in western and southwestern species. The whole number of determined specimens is eighteen thousand, representing 6,780 species. By far the greater portion of the species are North American, but seven hundred being natives of other parts of the world. It is to be

hoped that this herbarium will come into the possession of some institution which will make it accessible to the botanists of the country.

Palmer's Mexican and Arizona Plants of 1890.—The plants collected by Dr. Edward Palmer during the year 1890 have been determined by Mr. J. N. Rose, of the National Herbarium, whose report has just appeared as one of the "Contributions." A good many new species are described, one of the most interesting of which is *Echinopepon cirrhopedunculatus*, a near relative of our familiar *Echinocystis lobata*. In the new species the female flowers are borne upon slender, coiled, tendril-like peduncles, from three to six inches in length. Apparently we have here a hint as to the morphology of the tendrils of the Cucurbitaceæ. This would indicate their cauline nature.

Three Months of Elementary Botany.—By setting the student at work collecting green-slimes, pond-scums, smuts, leaf-spots, toad-stools, lichens, scouring rushes, together with flowering plants, many kinds of vegetable forms are presented to him, and their resemblances or differences readily impress themselves upon his mind. This discursive collecting is not so symmetrical or simple as the ordinary selective method which rejects anything without a flower at least half an inch in diameter. It is calculated however, to give a more just idea of the plant world as a whole. With reference to structure, much more can be seen with the unaided eye than teachers suppose. For example, a thin slice of squash stem held up to the light shows clearly enough the subepidermal tissues and the bicollateral structure of the vascular bundles. A vast amount of dissecting and anatomical work can be done with pins and pocket-knives. If rightly used, the eye is a splendid microscope, but one must use it with the "fine adjustment." Even things which it is fashionable to slight may become productive under proper handling. Phyllotaxy—that much abused and ridiculed section of anatomy and physiology—presents admirable fields of study in the mechanics of development. Close examination of the shoot-epidermis opens up almost every division of physiology. For the epidermal system is specialized for defence, nutrition, growth, irritability, attraction—sometimes — of insects, and, with its color, texture, thickness, extent, perforations, projections, secretions, is a most convenient and instructive object of attention in a three-months' course of botany. In connection with such work in morphology and physiology, the structure of flowers, the physiology of reproduction, the principles of classification may be

studied. The demonstrations—by the developmental chain from the lower to the highest plants—that the pollen plant is itself an independent plant, is instructive.

Let us see what the method of presentation should be in the department of plant physiology. In its modern aspect, this is rather the newest field of botanical investigation. It is commonly supposed to be quite beyond the resources of an ordinary equipment, and is mentally associated with regiments of flasks, brigades of induction-coils, and whole armies of expensive and delicate pieces of apparatus. Certainly all the resources of chemistry, physics, and mechanics may be brought to bear upon the science of botany, and the result is our present mechanical or physico-chemical theory of plant life. But, although one may conduct experiments of great delicacy, it is scarcely imperative, on that account, for the teacher trying to give an evenly balanced six fortnights of botany to present such experiments. The truth is, one may do most of the physiological experiments without apparatus. Seedlings planted in little boxes which may be set on edge illustrate geotropic curvatures; others set in the window illustrate the heliotropic position. To etiolate a plant needs but an empty flower-pot turned over it. Tissue tensions are illustrated by slicing a radish or parsnip and soaking awhile in water. Tendrils may be stimulated to curvature, bladderworts and pitcher-plants may be grown for examination, leaves may be covered with felt pads to illustrate the transitional movements of the chorophyl bodies within; the phenomena of wilting, artificial culture solutions, fermentation, temperature changes in germinated seeds, and a hundred others are demonstrated without difficulty.

For such a course there is no text-book. The teacher must give it by brief lectures, or better, by occasional dictations. Some such compilations as Dr. Goodale's "Physiological Botany," or "Vine's Lectures on Plant Physiology," may be used for reference. Pfeffer and Detmer are the best authors for those who read German, and Frank's little books are admirable. By such a course, brief though it may be, the student will learn that there is not a position of a leaf, not a coil in the tendril, which has not its sufficient cause. Thus he will learn in proper fashion what is meant by scientific investigation.

It may be urged, and not without reason, that such courses as have been briefly outlined are too extended for the time allotted them. Such is not the case, however, for such courses are practical, as is shown by their adoption in more than one college and academy in America. Students should not be persistently underrated. Even

the dull ones will be able to radiate a little light of their own if opportunity is given them to do something more than repeat the feeble beams of a text-book. And this is the greatly needed thing; this is the essential thing,—that students should think for themselves. Original thought is the spirit of the present, the genius of the future. A rational course of study is the alembic which can precipitate such thought from a solution of confused and half-formed notions. Science itself is to be defined as that mass of facts within experience by which we criticize our primitive ideas. Therefore, everything should be bent to bringing forth true thought from the pupil; otherwise he cannot arrive at intellectual manhood.—CONWAY MCMILLAN, *in Education.*

ZOOLOGY.

The Anatomy of Phagocata.—Woodworth's paper[1] on the structure of this Triclad is a valuable contribution to our knowledge of the Turbellaria. This worm, described by Leidy forty years ago, has been neglected until now. Woodworth has investigated the anatomy in a thorough manner, and besides confirming Leidy's account of the many pharynges—doubted by several helminthologists—has investigated all parts of the animal. Phagocata possesses a main pharynx which opens at the junction of the three branches of the alimentary tract, and, besides, many others which open into the posterior trunks of the intestine. These are arranged without apparent order, except that the further they are from the median pharynx the smaller they become. The development of the rhabdites is traced. They arise in gland cells lying in the mesenchyme, and pass up into the hypodermis, where they have an intercellular position, by means of tubular projections of the mother cells. Woodworth thinks the function of the rhabdites to be to aid in the capture of prey, since by their slow solution in water they form a thick mucus. The body of the animal is usually darkly pigmented, the pigment being scattered granules intercellular in position. In its nervous system Phagocata stands intermediate between Gunda and Rhynchodesmus. There is a superficial and a deeper portion, the two being indirectly connected by means of a marginal nerve. The vasa efferentia are products of the testes; and the growth of the yolk glands

[1] Bull. Mus. Comp. Zool., XXI., No. 1, 1891.